The documentation and process conversion measures necessary to comply with this revision shall be completed by 12 June 1998

INCH-POUND

MIL-PRF-19500/366E
12 March 1998
SUPERSEDING
MIL-S-19500/366D
14 April 1995

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, AMPLIFIER
TYPES 2N3498, 2N3498L, 2N3499, 2N3499L, 2N3500, 2N3500L, 2N3501 AND 2N3501L
JAN, JANTX, JANTXV, AND JANS

Device types 2N3498, 2N3499, 2N3500 and their corresponding L suffix versions are inactive for new design as of 14 April 1995.

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, low-power amplifier and switching transistors. Four levels of product assurance are provided for each device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. See figure 1 (similar to TO- 5/39).

1.3 Maximum ratings.

Types 1/	P_T 2/ T_A = +25°C	P_T 3/ T_C = +25°C	V_{CBO}	V_{CEO}	V_{EBO}	I_C	$R_{\theta JA}$	$R_{\theta JC}$	T_{STG} and T_{OP}
	W	W	V dc	V dc	V dc	mA dc	°C /W	°C/W	°C
2N3498	1	5	100	100	6	500	175	35	-55 to +200
2N3499	1	5	100	100	6	500	175	35	-55 to +200
2N3500	1	5	150	150	6	300	175	35	-55 to +200
2N3501	1	5	150	150	6	300	175	35	-55 to +200

1/ Electrical characteristics for "L" suffix devices are identical to their corresponding "non L" suffix devices.
2/ Derate linearly 5.71 mW/°C for TA > +25°C.
3/ Derate linearly 28.6 mW/°C for TC > +25°C.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad Street, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

1.4 Primary electrical characteristics at T_A +25°C.

Type 1/	h_{FE} at V_{CE} = 10 V dc				$\|h_{fe}\|$ V_{CE} = 20 V dc I_C = 20 mA dc f = 100 MHz	C_{obo} V_{CE} = 10 V dc I_E = 0 100 kHz ≤f ≤ 1 MHz
	h_{FE1} 2/ I_C = 0.1 mA dc	h_{FE4} 2/ I_C = 150 mA dc	h_{FE5} 2/ I_C = 300 mA dc	h_{FE6} 2/ I_C = 500 mA dc		
	Min Max	Min Max	Min Max	Min Max	Min Max	Min Max
2N3498	20	40 120		15	1.5 8	10
2N3499	35	100 300		20	1.5 8	10
2N3500	20	40 120	15		1.5 8	8
2N3501	35	100 300	20		1.5 8	8

1/ Electrical characteristics for the "L" suffix devices are identical to the corresponding "non L" suffix devices.
2/ Pulsed (see 4.5.1)

Types 1/	$V_{CE(sat)}$ 2/		$V_{BE(sat)}$ 2/		t_{on}	t_{off}
	I_C = 150 mA dc I_B = 15 mA dc	I_C = 300 mA dc I_B = 30 mA dc	I_C = 150 mA dc I_B = 15 mA dc	I_C = 300 mA dc I_B = 30 mA dc	I_C = 150 mA dc I_{B1} = 15 mA dc V_{EB} = 2 V dc	I_C = 150 mA dc I_{B1} = -I_{B2} = 15 mA dc
	Min Max	Min Max	Min Max	Min Max	Max ns	Max ns
2N3498		0.6		1.4	115	1,150
2N3499		0.6		1.4	115	1,150
2N3500	0.4		1.2		115	1,150
2N3501	0.4		1.2		115	1,150

1/ Electrical characteristics for the "L" suffix devices are identical to the corresponding "non L" suffix devices.
2/ Pulsed see 4.5.1.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

MILITARY

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500 and as specified herein.

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

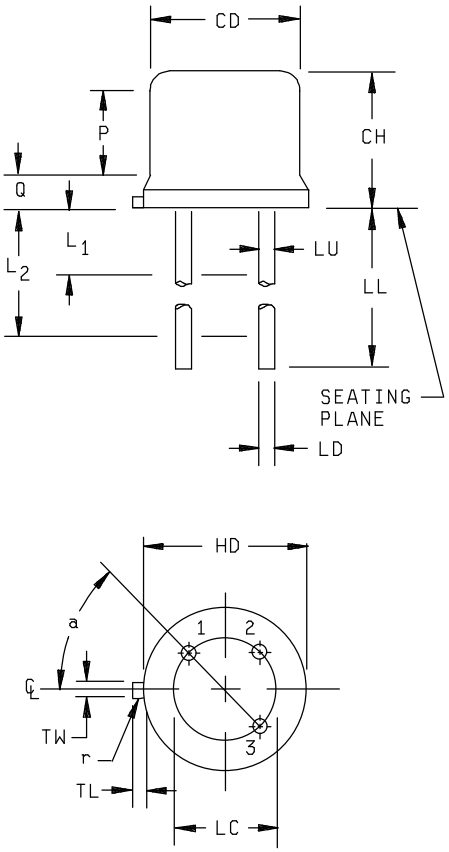
3.4 Interface requirements and physical dimensions. The interface requirements and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1 herein.

3.4.1 Lead material and finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.6 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.7 Electrical test requirements. The electrical test requirements shall be the subgroups specified in 4.4.2 and 4.4.3 herein.



Symbol	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		6
LD	.016	.021	0.41	0.53	7
LL	See notes 7, 12, and 13				
LU	.016	.019	0.41	0.48	7, 13
L_1	- - -	.050	- - -	1.27	13
L_2	.250	- - -	6.35	- - -	13
TL	.029	.045	0.74	1.14	3
TW	.028	.034	0.71	0.86	10, 11
P	.100	- - -	2.54	- - -	5
Q	- - -	.050	- - -	1.27	4
r	- - -	.010	- - -	.250	11
α	45° TP		45° TP		6

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Symbol TL is measured from HD maximum.
4. Details of outline in this zone are optional.
5. Symbol CD shall not vary more than .010 (0.25 mm) in zone P. This zone is controlled for automatic handling.
6. Leads at gauge plane .054 inch (1.37 mm) +.001 inch (0.03 mm) -.000 inch (0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) relative to tab. Device may be measured by direct methods or by gauge.
7. Symbol LD applies between L_1 and L_2. Dimension LD applies between L_2 and LL minimum. Lead diameter shall not exceed .042 inch (1.07 mm) within L_1 and beyond LL minimum.
8. Lead designation, shall be as follows: 1 - emitter, 2 - base, 3 - collector.
9. Lead number three is electrically connected to case.
10. Beyond r maximum, TW shall be held for a minimum length of .011 inch (0.28 mm).
11. Symbol r applied to both inside corners of tab.
12. For transistor types 2N3498, 2N3499, 2N3500, and 2N3501, LL = .50 inch (12.70 mm) minimum and .750 inch (19.05 mm) maximum. For transistor types 2N3498L, 2N3499L, 2N3500L, and 2N3501L, LL = 1.50 inch (38.10 mm) minimum and 1.750 inch (44.45 mm) maximum.
13. All three leads.

FIGURE 1. Physical dimensions similar to TO - 5/39.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3).

c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 Screening (JANS, JANTXV, and JANTX levels only). Screening shall be in accordance with appendix E, table IV of MIL-PRF-19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see appendix E, table IV of MIL-PRF-19500)	Measurement	
	JANS level	JANTX and JANTXV levels
3C	Thermal impedance (see 4.3.2)	Thermal impedance (see 4.3.2)
7	Hermetic seal (optional)	1/
9	I_{CBO2} and h_{FE4}	Not applicable
11	I_{CBO2} and h_{FE4}; ΔI_{CB012} 100 percent of initial value or 5 nA dc, whichever is greater; Δh_{FE4} = ± 15 percent of initial value.	I_{CBO2} and h_{FE4}
12	See 4.3.1	See 4.3.1
13	Subgroups 2 and 3 of table I herein; ΔI_{CB02} = 100 percent of initial value or 5 na dc, whichever is greater; Δh_{FE4} = ± 15 percent of initial value.	Subgroup 2 of table I herein; ΔI_{CB02} = 100 percent of initial value or 5 na dc, whichever is greater; Δh_{FE4} = ± 15 percent of initial value.

1/ Hermetic seal test shall be performed in either screen 7 or screen 14.

4.3.1 Power burn-in conditions. Power burn-in conditions are as follows: T_A = Room ambient as defined in the general requirements of MIL-STD-750 (see 4.5):

JANS (all device types) ..... V_{CB} = 30 V dc, P_T = 1.0 W .

JANTX, and JANTXV levels:
2N3498, 2N3499..... V_{CB} = 60 V dc, P_T = 1.0 W.
2N3500, 2N3501..... V_{CB} = 100 V dc, P_T = 1.0 W.

NOTE: No heat sink or forced air cooling on the devices shall be permitted. Electrical characteristics for the "L" suffix devices are identical to the corresponding non "L" suffix devices.

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500 and as specified herein. If alternate screening is being performed per E.5.3.1d of MIL-PRF-19500, a sample of screened devices shall be submitted to and pass the requirements of Group A1 and A2 inspection only (table VIb, group B, subgroup 1 is not required to be performed again if group B has already been satisfied per 4.4.2).

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with appendix E, table V of MIL-PRF-19500 and table I herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VIa (JANS) and 4.4.2.1 herein; and table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and 4.4.2.2 herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.2.1 Group B inspection, appendix E, table VIa (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
B4	1037	2N3498, 2N3498L, 2N3499, 2N3499L - V_{CE} = 10 V dc; 2N3500, 2N3500L, 2N3501, 2N3501L - V_{CE} = 15 V dc; P_T = 1.0 W at : T_A = Room ambient as defined in the general requirements of MIL-STD-750 (see 4.5; t_{on} = t_{off} = 3 minutes minimum for 2,000 cycles. No heat sink or forced-air cooling on devices shall be permitted.
B5	1027	V_{CB} = 10 V dc; T_A = 125°C ± 25°C for 96 hours, P_T = 1 W at T_A = 100°C or adjusted as required by the chosen T_A to give an average lot T_J = 275°C.
B5	2037	(Al-Au die-interconnect only) test condition A.

4.4.2.2 Group B inspection appendix E, table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500. 1/

Subgroup	Method	Condition
B3	1027	2N3498, 2N3498L, 2N3499, 2N3499L: V_{CB} = 75 V dc; 2N3500, 2N3500L, 2N3501, 2N3501L: V_{CB} = 100 V dc; P_T = 1.0 W; T_A = room ambient as defined in the general requirements of MIL-STD-750. No heat sink or forced-air cooling on the devices shall be permitted.
B5	3131	See 4.5.2.

1/ Separate samples may be used for each step. For rules on resubmission for failed steps, see MIL-PRF-19500 rules on resubmission of failed subgroups.

4.4.2.3 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

a. Samples shall be selected from each wafer lot from a die fabrication line that the manufacturer chooses to “certify” for the die design used in products manufactured to this specification.

b. Must be chosen from an inspection lot that has been submitted to and passed group A conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (subgroups B3 and B5 for JANS, and group B for JAN, JANTX and JANTXV) may be pulled prior to the appliction of final lead finish.

4.4.2.4 Product acceptable for delivery. The product shall be acceptable for delivery only after the successful completion of all group B testing and shall be comprised of die meeting the following requirements:

a. Manufactured on the same certified die fabrication line as the sample selected for 4.4.2.3.

b. The die lot was manufactured (using start or completion dates, as manufacturer selects to consistently use) within three months following the wafer lot used for sample selection in paragraph 4.4.2.3. Group B shall not be required more than once for any wafer lot.

4.4.3 Group C inspection, JANS. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table VII of MIL-PRF-19500 and 4.4.3.1 herein. Electrical measurements (end-points) and delta requirements shall be in accordance with the applicable steps of table II herein.

4.4.3.1 Group C inspection, appendix E, table VII (JANS) of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Test condition E.
C6	1026	2N3498, 2N3498L, 2N3499, 2N3499L: V_{CB} = 75 V dc; 2N3500, 2N3500L, 2N3501, 2N3501L: V_{CB} = 100 V dc; P_T = 1.0 W; T_A = room ambient as defined in the general requirements of MIL-STD-750. No heat sink or forced-air cooling on the devices shall be permitted.

4.4.3.2 Group C inspection, JAN, JANTX and JANTXV. Group C inspection (JAN, JANTX and JANTXV, package related tests) shall be as follows and shall include those package or case related tests which are performed periodically. Group C test on each package family shall be performed on devices from each six months production of devices (based on inspection lot identification codes) for each assembly location and die attach method. Electrical measurements (end points) and delta requirements shall be in accordance with the steps of table II herein as specified in the notes for table II. The sample size for each of these subgroups is: 22 devices, c = 0. Separate samples may be used for each step. For rules on resubmission for failed steps, see MIL-PRF-19500 rules on resubmission of failed subgroups.

Subgroup	Method	Condition
1	2066	
2	1051	Test condition C
3	2036	Test condition E

4.4.3.3 Group C sample selection. Samples for subgroups in group C shall be chosen at random from any lot containing the intended package type and lead finish procured to the same specification which is submitted to and passes group A tests for conformance inspection. Testing of a subgroup using a single device type enclosed in the intended package type shall be considered as complying with the requirements for that subgroup.

4.4.3.4 Product acceptable for delivery. The product which may be accepted for delivery based a successful completion of group C testing shall be product of the particular package type with lot inspection identification codes of the 52 successive weeks beginning with the inspection lot identification code of the successful group C sample (i.e. the inspection codes accepted for delivery based on successful group C testing will include those sealed during the approximate 10 weeks during which the sample was being screened and tested plus those sealed in the 42 weeks following successful completion of group C testing making a total C testing of 52 successive calendar weeks). A manufacturer shall not accept product for delivery until after successful completion of the group C testing on product of the applicable package type with an inspection lot identification code less than 51 weeks prior to the inspection identification code of the product being considered for acceptance.

4.5 Method of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

4.5.2 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following conditions shall apply:

a. Collector current magnitude during heating shall be 30 mA dc.

b. Collector emitter voltage magnitude shall be 20 V dc.

c. Reference temperature measuring point shall be case ambient air.

d. Reference point temperature shall be 25°C.

e. Mounting arrangement shall be case to ambient air.

f. Maximum limit shall be $R_{\theta JA}$ = 175°C/W.

TABLE I. Group A inspection. 1/

Inspection 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Collector to base, cutoff current	3036	Bias condition D;	I_{CBO1}			
2N3498, 2N3499		V_{CB} = 100 V dc			10	μA dc
2N3500, 2N3501		V_{CB} = 150 V dc			10	μA dc
Breakdown voltage, collector to emitter	3011	Bias condition D; ; I_C = 10 mA dc; pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N3498, 2N3499				100		V dc
2N3500, 2N3501				150		V dc
Emitter to base, cutoff current	3061	Bias condition D; V_{EB} = 6 V dc	I_{EBO1}		10	μA dc
Collector to base cutoff current	3036	Bias condition D;	I_{CBO2}			
2N3498, 2N3499		V_{CB} = 50 V dc			50	nA dc
2N3500, 2N3501		V_{CB} = 75 V dc			50	nA dc
Emitter to base cutoff current	3061	Bias condition D; V_{EB} = 4 V dc	$I_{EBO}2$		25	nA dc
Collector to emitter saturation voltage	3071	I_C = 10 mA dc; I_B = 1 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)1}$ 3/		0.2	V dc
Collector to emitter saturation voltage	3071	I_C = 150 mA dc; I_B = 15 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)2}$ 3/		0.4	V dc
2N3500, 2N3501 only						
Collector to emitter saturation voltage	3071	I_C = 300 mA dc; I_B = 30 mA dc; pulsed (see 4.5.1)	$V_{CE(sat)3}$ 3/		0.6	V dc
2N3498, 2N3499 only						
Base emitter saturation voltage	3066	Test condition A; I_C = 10 mA dc; I_B = 1 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)1}$ 3/		0.8	V dc

See footnotes at end of table.

TABLE I. Group A inspection - Continued. 1/

Inspection 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Base emitter saturation voltage 2N3500, 2N3501 only	3066	Test condition A; I_C = 150 mA dc; I_B = 15 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)2}$ 3/		1.2	V dc
Base emitter saturation voltage 2N3498, 2N3499 only	3066	Test condition A; ; I_C = 300 mA dc; I_B = 30 mA dc; pulsed (see 4.5.1)	$V_{BE(sat)3}$ 3/		1.4	V dc
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 0.1 mA dc; pulsed (see 4.5.1)	h_{FE1}			
2N3498, 2N3500 2N3499, 2N3501				20 35		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 1.0 mA dc; pulsed (see 4.5.1)	h_{FE2}			
2N3498, 2N3500 2N3499, 2N3501				20 50		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 10 mA dc; pulsed (see 4.5.1)	h_{FE3}			
2N3498, 2N3500 2N3499, 2N3501				35 75		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 150 mA dc; pulsed (see 4.5.1)	h_{FE4}			
2N3498, 2N3500 2N3499, 2N3501				40 100	120 300	
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 300 mA dc; pulsed (see 4.5.1)	h_{FE5}			
2N3500 2N3501				15 20		
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 500 mA dc; pulsed (see 4.5.1)	h_{FE6}			
2N3498 2N3499				15 20		

See footnotes at end of table.

TABLE I. Group A inspection - Continued. 1/

Inspection 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High-temperature operation:		T_A = +150°C				
Collector to base cutoff current	3036	Bias condition D;	I_{CBO3}		50	µA dc
2N3498, 2N3499		V_{CB} = 50 V dc				
2N3500, 2N3501		V_{CB} = 75 V dc				
Low-temperature operation:		T_A = -55°C				
Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 150 mA dc; pulsed (see 4.5.1)	h_{FE7}			
2N3498, 2N3500				22		
2N3499, 2N3501				45		
Subgroup 4						
Magnitude of common-emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 20 V dc; I_C = 20 mA dc; f = 100 MHz	$\|h_{fe}\|$	1.5	8	
Small-signal short-circuit forward-current transfer ratio	3206	V_{CE} = 10 V dc; I_C = 10 mA dc; f = 1 kHz	h_{fe}			
2N3498, 2N3500				50	300	
2N3499, 2N3501				75	375	
Open circuit output capacitance	3236	V_{CB} = 10 V dc; I_E = 0; 100 kHz ≤ f ≤ 1 MHz	C_{obo}			
2N3498, 2N3499					10	pF
2N3500, 2N3501					8	pF
Input capacitance (output open-circuited)	3240	V_{EB} = 0.5 V dc; I_C = 0; 100 kHz ≤ f ≤ 1 MHz	C_{ibo}		80	pF
Noise figure (Test 1)	3246	V_{CE} = 10 V dc; I_C = 0.5 mA dc; Rg = 1 kΩ; f = 1 kHz	NF		16	dB
Noise figure (Test 2)	3246	V_{CE} = 10 V dc; I_C = 0.5 mA dc; Rg = 1 kΩ; f = 10 kHz	NF		6	dB

See footnotes at end of table.

TABLE I. Group A inspection 1/ - Continued.

Inspection 2/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued						
Turn-on time		V_{EB} = 12 V dc; I_C = 150 mA dc; I_{B1} = 15 mA dc; (see figure 2)	t_{on}		115	ns
Turn-off time		I_C = 150 mA dc; $I_{B1} = I_{B2}$ = -15 mA dc; (see figure 2)	t_{off}		1,150	ns
Subgroup 5						
Safe operating area (continuous dc)	3051	T_C = 25°C; $t_r \geq 10$ ns; 1 cycle; (see figure 3); t = 1 s				
Test 1						
2N4598, 3N3499		V_{CE} = 10 V dc; I_C = 500 mA dc				
2N3500, 2N3501		V_{CE} = 16.67 V dc; I_C = 300 mA dc				
Test 2		V_{CE} = 40 V dc; I_C = 125 mA dc				
Test 3		V_{CE} = 80 V dc; I_C = 60 mA dc				
Safe operating area (clamped switching)	3053	T_A = 25°C; (see figure 4); device fails if clamp voltage is not reached				
2N3498, 2N3499		I_B = 85 mA dc; I_C = 500 mA dc				
2N3500, 2N3501		I_B = 50 mA dc; I_C = 300 mA dc				
Electrical measurements		See table II, steps 1 and 7				
Subgroups 6 and 7						
Not applicable						

1/ For sampling plan, see MIL-PRF-19500.
2/ Electrical characteristics for "L" suffix devices are identical to the corresponding "non L" suffix devices.
3/ Maximum limit for this test characterized at ≤ .125 inch (3.18 mm) from the case.

TABLE II. Group B and C electrical measurements. 1/ 2/ 3/

Step	Inspection 4/	MIL-STD-750		Symbol	Limit		Unit
		Method	Conditions		Min	Max	
1.	Collector to base cutoff current 2N3498, 2N3499 2N3500, 2N3501	3036	Base condition D; V_{CB} = 50 V dc V_{CB} = 75 V dc	I_{CBO2}		50	nA dc
2.	Collector to base cutoff current 2N3498, 2N3499 2N3500, 2N3501	3036	Bias condition D; V_{CB} = 50 V dc V_{CB} = 75 V dc	I_{CBO2}		100	nA dc
3.	Emitter to base cutoff current	3061	Bias condition D; V_{EB} = 4 V dc	I_{EBO2}		25	nA dc
4.	Collector to emitter voltage (saturated)	3071	I_C = 10 mA dc; I_B = 1.0 mA dc pulsed (see 4.5.1)	$V_{CE(sat)1}$ 5/		0.2	V dc
5.	Base to emitter voltage (saturated)	3066	Test condition A; I_C = 10 mA dc; I_B = 1.0 mA dc pulsed (see 4.5.1)	$V_{BE(sat)1}$ 5/		0.8	V dc
6.	Forward-current transfer ratio 2N3498, 2N3500 2N3499, 2N3501	3076	V_{CE} = 10 V dc; I_C = 10 mA dc	h_{FE3}	 35 75		
7.	Forward-current transfer ratio 2N3498, 2N3500 2N3499, 2N3501	3076	V_{CE} = 10 V dc; I_C = 150 mA dc pulsed (see 4.5.1)	h_{FE4}	 40 100	 120 300	
8.	Collector to base cutoff current 2N3498, 2N3499 2N3500, 2N3501	3036	Bias condition D; V_{CB} = 50 V dc V_{CB} = 75 V dc	ΔI_{CBO2} 6/	± 100 percent of initial value or 5 nA dc, whichever is greater.		
9.	Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 10 mA dc pulsed (see 4.5.1)	Δh_{FE3} 6/	± 25 percent change from initial reading		
10.	Forward-current transfer ratio	3076	V_{CE} = 10 V dc; I_C = 150 mA dc pulsed (see 4.5.1)	Δh_{FE4} 6/	± 25 percent change from initial reading		
11.	Collector to emitter voltage (saturated)	3071	I_C = 10 mA dc; I_B = 1.0 mA dc pulsed (see 4.5.1)	$\Delta V_{CE(sat)1}$ 5/ 6/	± 50 mV dc change from previous measured value		

TABLE II. Group B and C electrical measurements 1/ 2/ 3/ - Continued.

1/ The electrical measurements for appendix E, table VIa (JANS) of MIL-PRF-19500 are as follows:

a. Subgroup 3, see table II herein, steps 1, 3, 4, 5, 6, and 7.

b. Subgroup 4, see table II herein, steps 2, 3, 4, 5, 6, 7, 10, and 11.

c. Subgroup 5, see table II herein, steps 2, 3, 4, 5, 6, 7, 8, and 9.

2/ The electrical measurements for appendix E, table VI (JAN, JANTX, and JANTXV) of MIL-PRF-19500 are as follows:

a. Subgroup 2, see table II herein, steps 1 and 7.

b. Subgroups 3 and 6, see table II herein, steps 2, 7, and 10.

3/ The electrical measurements for appendix E, table VII of MIL-PRF-19500 are as follows:

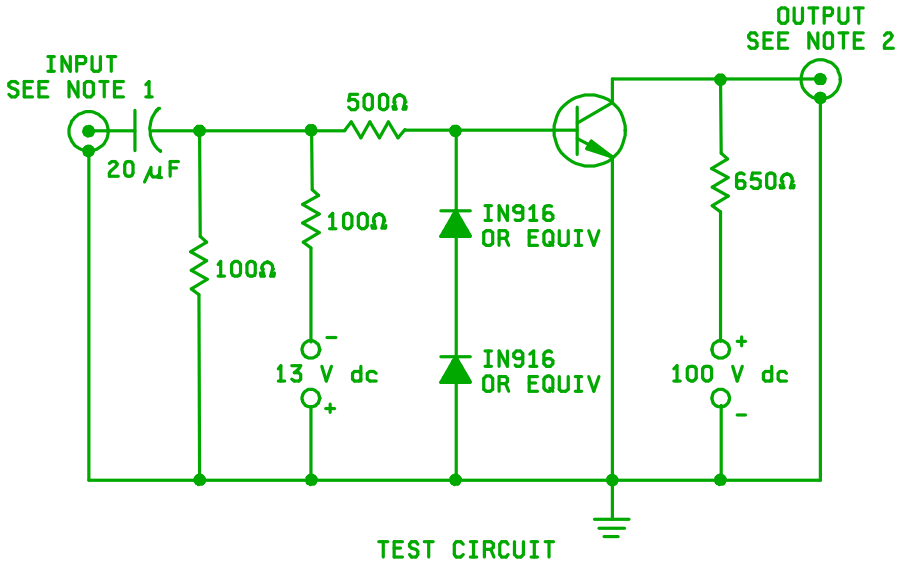
a. Subgroups 2 and 3, see table II herein, steps 1, 3, 6, and 7 (JANS); steps 1 and 7 (JAN, JANTX, and JANTXV).

b. Subgroup 6, see table II herein, steps 2, 3, 6, 7, and 8 (JANS); steps 2, 7, and 10 (JAN, JANTX, and JANTXV).

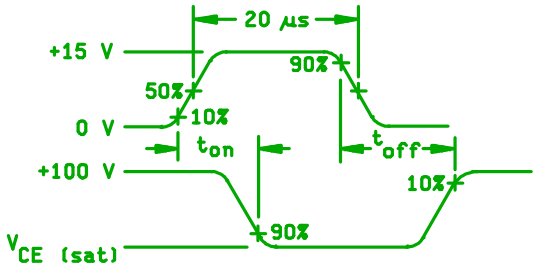
4/ Electrical characteristics for "L" suffix devices are identical to their corresponding "non L" suffix devices.

5/ Maximum limit for this test characterized at ≤ .125 inch (3.18 mm) from the case.

6/ Devices which exceed the group A limits shall not be returned to the lot, but will not be considered failures.



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES:

1. The input waveform is supplied by a pulse generator with the following characteristics:
   Pulse width = 20 µs, Pulse repetition rate = 1 kHz, rise time (t_r) and fall time (t_f) ≤ 10 ns, duty cycle ≤ 2 percent.
2. The output waveform is monitored on a sampling oscilloscope with Z_{in} ≥ 1 MS and t_r ≤ 1 ns.

FIGURE 2. Turn-on turn-off switching time test circuit.

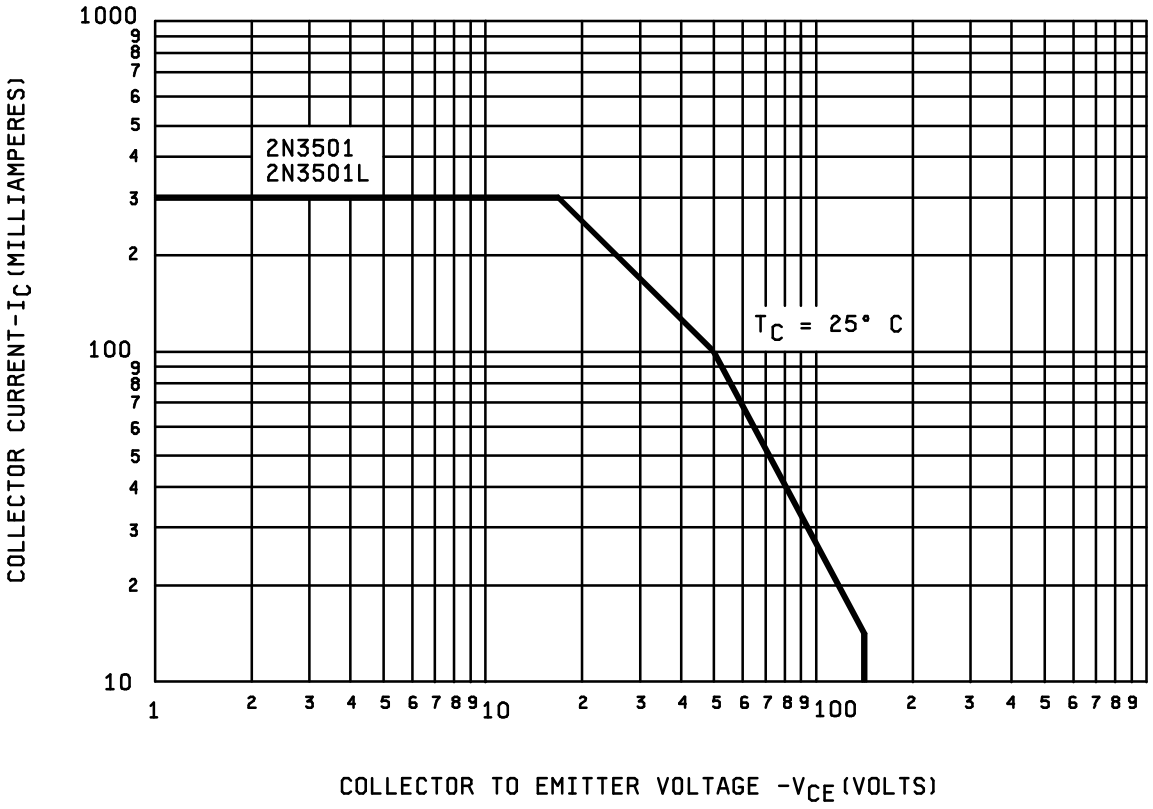
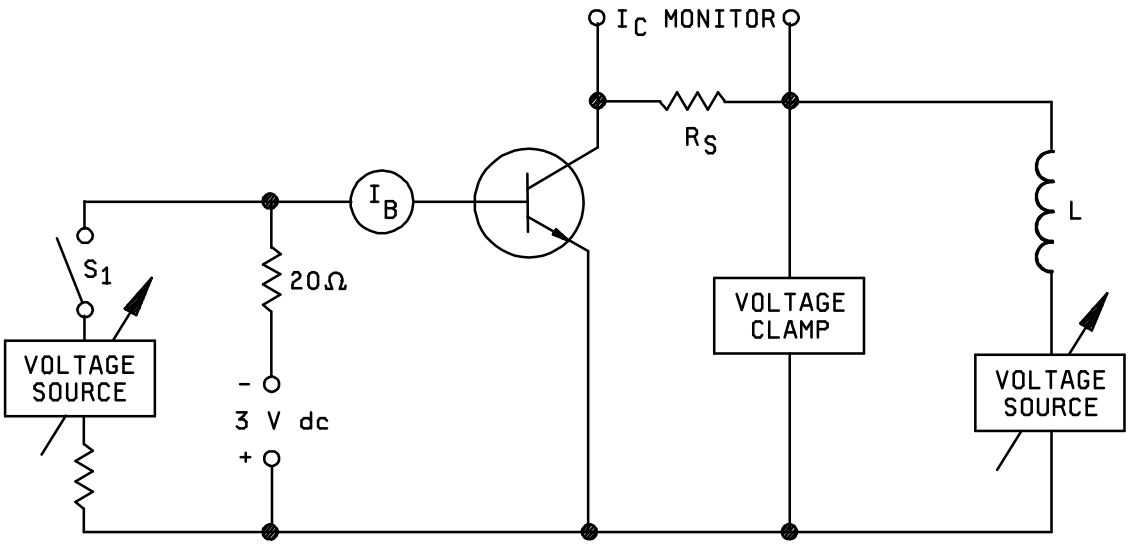


FIGURE 3. Maximum safe operating area.



Voltage clamp:

2N3498, 2N3498L, 2N3499, 2N3499L = 100 V dc
2N3500, 2N3500L, 2N3501, 2N3501L = 150 V dc

R_S ≤1.0 ohm (noninductive)
L = (STANCOR C-2688, 0.425 ohm, or equivalent)

Procedure:

1. With switch S_1 closed, set the specified test conditions.
2. Open S_1.
3. Perform specified end-point tests.

FIGURE 4. Clamped inductive sweep test circuit diagram.

5. PACKAGING

5.1 Packaging. Packaging shall prevent mechanical damage of the devices during shipping and handling and shall not be detrimental to the device. When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

5.2 Marking. Unless otherwise specified (see 6.2), marking shall be in accordance with MIL-PRF-19500.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. See MIL- PRF-19500.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List QPL No.19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, ATTN: DSCC-VQE, 3990 East Broad Street, Columbus, OH 43216-5000.

6.4 Substitutability. The 2N3498, 2N3499 and 2N3500 devices (including "L" suffix versions) are now inactive for new design. The 2N3501 is the preferred item and is a direct substitute for the 2N3499, however, due to the higher gain of the 2N3501, it should be evaluated on a case by case basis before it is substituted for the 2N3498 and 2N3500.

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Army - CR
Navy - EC
Air Force - 17

Review activities:
Army - AR, MI, SM
Navy - AS, CG, MC
Air Force - 19, 85

Preparing activity:
DLA - CC

(Project 5961-1919)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.

2. The submitter of this form must complete blocks 4, 5, 6, and 7.

3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	**1. DOCUMENT NUMBER** MIL-PRF-19500/366E	**2. DOCUMENT DATE (YYMMDD)** 980312

3. DOCUMENT TITLE SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, AMPLIFIER TYPES 2N3498, 2N3498L, 2N3499, 2N3499L, 2N3500, 2N3500L, 2N3501 AND 2N3501L JAN, JANTX, JANTXV, AND JANS

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) Commercial DSN FAX EMAIL	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. Point of contact: Alan Barone	b. TELEPHONE Commercial: 614-692-0510 DSN: 850-0510 FAX: 614-692-6939 EMAIL: alan_barone@dscc.dla.mil
c. ADDRESS: Defense Supply Center Columbus, ATTN: DSCC-VAT, 3990 East Broad Street, Columbus, OH 43216-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 DSN 289-2340